WHAT IS CLAIMED IS:

1. A magnet assembly for use in magnetic resonance measurements, comprising:

four or more pairs of magnets arranged to surround a tubular volume of space and provide in at least portion of the surrounded volume a substantially homogeneous magnetic field, the magnets of each pair being disposed diametrically opposite each other with respect to the surrounded volume with magnetization directions having substantially the same orientation, and adjacent magnets of the assembly being separated by gaps, thereby permitting magnetic flux between adjacent magnets to substantially extend into the surrounded volume.

2. The magnet assembly of claim 1, wherein gaps between adjacent magnets of the assembly comprise material of low magnetic permeability.

3. The magnet assembly of claim 1, further comprising:

a support structure that holds the magnets in position, with each magnet held at a distance from adjacent magnets in the magnet assembly, thereby creating the gaps between adjacent magnets.

4. The magnet assembly of claim 1, wherein the gaps between adjacent magnets comprise air or vacuum.

5. The magnet assembly of claim 1, wherein the pairs of magnets include:

a first pair of magnets oriented with their magnetizations pointing in a direction N, wherein N is substantially perpendicular to the axis,

a second pair of magnets oriented with their magnetizations pointing in a direction substantially opposite to N,

a third pair of magnets oriented with their magnetizations pointing in a direction between 1° and 179° away from N, and

a fourth pair of magnets oriented with their magnetizations pointing in a direction between 181° and 359° from N.

6. The magnet assembly of claim 1, the placement and magnetic properties of the magnets being selected to produce:

(i) a first magnetic field, substantially homogeneous, within an inner portion of the surrounded volume, and

(ii) a second magnetic field, substantially different from the first magnetic field, in the remainder of the surrounded volume.

7. The magnet assembly of claim 6, wherein the second magnetic field is generated by the extension into the surrounded volume of magnetic flux between adjacent magnets.

8. The magnet assembly of claim 6, wherein the second magnetic field is heterogeneous.

9. The magnet assembly of claim 6, wherein the inner portion of the surrounded volume has substantially cylindrical shape.

10. The magnet assembly of claim 1, wherein the magnets in the magnet assembly are characterized by dimensions, magnetic properties, and orientations selected to produce the second magnetic field substantially different from the homogeneous magnetic field.

11. The magnet assembly of claim 1, wherein at least one of the magnets in the magnet assembly comprises an electromagnet, the assembly further comprising:

a control circuit coupled to the electromagnet and configured to control the current provided to the electromagnet, and thereby to control the spatial profile of the first and second magnetic fields.

12. The magnet assembly of claim 1, further comprising:

at least one moveable tuning shim mounted within at least one of the gaps, wherein the tuning shim comprises ferromagnetic or diamagnetic or paramagnetic material, thereby

permitting control over the spatial profile of the magnetic fields through motion of the tuning shim(s) within gaps between adjacent magnets.

13. The magnet assembly of claim 1, wherein the magnets of the magnet assembly are equally spaced.

14. The magnet assembly of claim 1, wherein each of the gaps between adjacent magnets subtend about 13°-17° angular spacing.

15. The magnet assembly of claim 1, wherein the number of magnets in the magnet assembly totals 2(n+1), where n is an integer greater than 1.

16. The magnet assembly of claim 1 further adapted to receive within the enclosed volume core material from drilled rock.

17. The magnet assembly of claim 16 further comprising equipment designed to measure magnetic resonance signals from the core material disposed within the surrounded volume of space.

18. The magnet assembly of claim 1 further comprising a ring made of high permeability material, the ring disposed around the magnets to provide path for magnetic field lines of the magnets.

19. A method for carrying out nuclear magnetic resonance (NMR) analysis of materials in a portion of a core volume, the method comprising:

providing in the core volume a magnetic field having (1) a first substantially homogeneous magnetic field profile within pre-defined interior portion of the core volume, and (2) a second magnetic field profile, substantially different from the first magnetic field profile, in the remaining portion of the core volume;

applying radio frequency (RF) energy to the core volume;

receiving NMR signals in response to the applied RF energy; and

processing the received NMR signals to provide NMR analysis substantially only of materials located within the interior portion of the core volume.

20. The method of claim 19, wherein said processing comprises discarding NMR signals from the remaining portion of the core volume.

21. The method of claim 19, wherein said receiving comprises receiving NMR signals only from the interior portion of the core volume.

22. The method of claim 19, wherein the second magnetic field profile is substantially heterogeneous.

23. The method of claim 19, wherein the defined interior portion of the core volume has a substantially cylindrical shape.

24. The method of claim 19, wherein said providing a magnetic field comprises providing electric current to one or more electromagnets disposed near the core volume, the method further comprising:

changing a current supplied to the one or more electromagnets to adjust one or more of: (a) the first field profile within the interior portion of the core volume, (b) the shape of the interior portion of the core volume, and (c) the size of the interior portion of the core volume.

25. A magnet assembly comprising:

a plurality of spaced-apart magnets arranged about an outer surface that encloses a tubular volume, the spacing and magnetic properties of the plurality of magnets being selected to produce: (1) a first substantially homogeneous magnetic field within an inner portion of the enclosed volume, and (2) a second magnetic field, substantially different from the first magnetic field, within the remainder of the enclosed volume.

26. The magnet assembly of claim 25, wherein the second magnetic field is heterogeneous.

27. The magnet assembly of claim 25, wherein the plurality of magnets are equi-spaced.

28. The magnet assembly of claim 25, wherein the inner portion of the enclosed volume has substantially cylindrical shape.

29. The magnet assembly of claim 25, wherein the plurality of magnets comprises at least four pairs of magnets, the magnets of each pair being arranged diametrically opposite each other with respect to the enclosed volume; and

at least a first pair of the magnets having a magnetization direction "N",

at least a second pair of magnets having a magnetization direction "N"+180°,

at least a third pair of magnets having a magnetization direction pointing between "N"+45° and "N"+135°, the at least third pair of magnets providing an incremental change in magnetization direction between the first and second pair of magnets,

and at least a fourth pair of magnets having a magnetization direction pointing between "N"-45° and "N"-135°, and directed in a direction opposite that of the at least third pair of magnets, the at least fourth pair of magnets providing an incremental change in magnetization direction between the second and first pair of magnets.

30. The magnet assembly of claims 25, wherein the spacing of the plurality of magnets is approximately in the range of 13°-17°.

31. The magnet assembly of claims 25, wherein the plurality of magnets are further characterized by thickness, magnetic strengths and lengths that are selected as to produce the first magnetic field substantially different from the second magnetic field.

32. The magnet assembly of claim 25, wherein the plurality of magnets totals $2(n+1)n$, where n is an integer greater than 1.

33. The magnet assembly of claim 25, wherein one or more of the plurality of magnets is a permanent magnet.

34. The magnet assembly of claim 25, wherein one or more of the plurality of magnets is an electromagnet.

35. The magnet assembly of claim 25, wherein one or more of the plurality of magnets is an electromagnet, wherein the electromagnet is adjustable to control one or more of the intensity, orientation, and shape of the first magnetic field.

36. A method for constructing a magnet assembly, comprising:

disposing a first pair of magnets in diametrically opposing positions around a tubular volume of space, with each magnet in the first pair oriented with its magnetization pointing in a direction designated N;

disposing a second pair of magnets in diametrically opposite positions around the volume of space with the second pair of magnets substantially separated from the first pair of magnets, and with each magnet in the second pair oriented with its magnetization pointing in a direction substantially opposite to N;

disposing a third pair of magnets in diametrically opposite positions around the volume of space, with the third pair of magnets substantially separated from the first and second pairs of magnets, and with each magnet in the third pair oriented with its magnetization pointing between 1° and 179° from N;

disposing a fourth pair of magnets in diametrically opposite positions around the volume of space, with the fourth pair of magnets substantially separated from the first, second, and third pairs of magnets, and with each magnet in the fourth pair oriented with its magnetization pointing between about181° and 359° from N.

37. The method of claim 36, the location and magnetic properties of the magnets being selected to produce:

(i) a first magnetic field, substantially homogeneous, within a first subregion of the central region, and

(ii) a second magnetic field, substantially different from the first magnetic field, within a second subregion of the central region.

38. The method of claim 37, wherein the second magnetic field is heterogeneous.

39. The method of claim 37, wherein the first subregion has substantially cylindrical shape.

40. The method of claim 36, wherein said disposing the first, second, third, and fourth pairs of magnets comprises disposing the magnets of the first, second, third, and fourth pairs into equally-spaced coplanar positions around the enclosed volume.

41. The method of claim 36, wherein said disposing the first, second, third, and fourth pairs of magnets comprises disposing the magnets of the first, second, third, and fourth pairs into equally-spaced coplanar positions separated by about 13°-17° around the enclosed volume.

42. A magnet assembly comprising:

six or more pairs of magnets, the magnets of each pair disposed opposite each other around an axis such that a region of space is surrounded by the magnets with the axis passing through the surrounded region; wherein the pairs of magnets include:

a first pair of magnets oriented with their magnetizations pointing in a direction N, wherein N is substantially perpendicular to the axis;

a second pair of magnets oriented with their magnetizations pointing in a direction substantially perpendicular to the axis and substantially opposite to N;

a third pair of magnets oriented with their magnetizations pointing in a direction substantially perpendicular to the axis and between about 1° and 90° from N;

a fourth pair of magnets oriented with their magnetizations pointing in a direction substantially perpendicular to the axis and between about 90° and 179° from N;

a fifth pair of magnets oriented with their magnetizations pointing in a direction substantially perpendicular to the axis and between about 181° and 270° from N; and

a sixth pair of magnets oriented with their magnetizations pointing in a direction substantially perpendicular to the axis and between about 270° and 359° from N.

43. The magnet assembly of claim 42, further comprising:

gaps interposed between adjacent magnets in the magnet assembly, thereby permitting magnetic flux between adjacent magnets to substantially extend into the surrounded region.

44. The magnet assembly of claim 43, wherein the gaps comprise material of low magnetic permeability.

45. The magnet assembly of claim 42, further comprising:

a support structure that holds the magnets in position, with each magnet held at a distance from adjacent magnets in the magnet assembly, thereby permitting magnetic flux between adjacent magnets to substantially extend into the surrounded region.

46. The magnet assembly of claim 42, the positions and magnetic properties of the magnets being selected to produce:

(1) a first magnetic field, substantially homogeneous, within a first subregion of the surrounded region, and

(2) a second magnetic field, substantially different from the first magnetic field, within a second subregion of the surrounded region, wherein the second subregion is located around the first subregion.

47. The magnet assembly of claim 46, wherein the second magnetic field is heterogeneous.

48. The magnet assembly of claim 46, wherein the first subregion has substantially cylindrical shape.

49. The magnet assembly of claim 46, wherein the magnets in the magnet assembly are characterized by dimensions, magnetic properties, and orientations selected to produce the second magnetic field substantially different from the first magnetic field.

50. A magnet assembly comprising:

four or more magnets disposed around a tubular volume of space, the magnets being disposed so that their magnetization directions have substantially the same orientation, and adjacent magnets of the assembly being separated by gaps, thereby permitting magnetic flux between adjacent magnets to substantially extend into the surrounded volume; and

a ring made of high permeability material, the ring disposed around the magnets to provide path for magnetic field lines of the magnets.

51. The magnet assembly of claim 50, wherein the ring is made of ferromagnetic material.

52. The magnet assembly of claim 50, wherein the ring comprises two or more elements, with gaps between the two or more elements.

53. The magnet assembly of claim 50, wherein the ring is a continuous cylindrical element.

54. The magnet assembly of claim 50, wherein gaps between adjacent magnets of the assembly comprise material of low magnetic permeability.

55. The magnet assembly of claim 50, further comprising:

a support structure that holds the magnets in position, with each magnet held at a distance from adjacent magnets in the magnet assembly, thereby creating the gaps between adjacent magnets.

56. The magnet assembly of claim 50, wherein the gaps between adjacent magnets comprise air or vacuum.

57. The magnet assembly of claim 50, the placement and magnetic properties of the magnets and the gaps therebetween being selected to produce:

(i) a first magnetic field, substantially homogeneous, within an inner portion of the surrounded volume, and

(ii) a second magnetic field, substantially different from the first magnetic field, in the remainder of the surrounded volume.

58. The magnet assembly of claim 57, wherein the second magnetic field is heterogeneous.

59. The magnet assembly of claim 50, wherein the inner portion of the surrounded volume has substantially cylindrical shape.

60. The magnet assembly of claim 50, wherein at least one of the magnets in the magnet assembly comprises an electromagnet, and the assembly further comprises a control circuit coupled to the electromagnet and configured to control the current provided to the electromagnet, and thereby to control the spatial profile of the first and second magnetic fields.

61. The magnet assembly of claim 50, further comprising:

at least one moveable tuning shim mounted within at least one of the gaps, wherein the tuning shim comprises ferromagnetic or diamagnetic or paramagnetic material, thereby permitting control over the spatial profile of the magnetic fields through motion of the tuning shim(s) within gaps between adjacent magnets.

62. The magnet assembly of claim 50, wherein the number of magnets in the magnet assembly totals 2(n+1), where n is an integer greater than 1.

63. The magnet assembly of claim 50 further adapted to receive within the enclosed volume core material from drilled rock.

64. The magnet assembly of claim 63 further comprising equipment designed to measure magnetic resonance signals from the core material disposed within the surrounded volume of space.